

Oil and Gas Development Overview

NPS Western Energy Summit
January 21–23, 2003

National Park Service
U.S. Department of the Interior

Geologic Resources Division
www2.nature.nps.gov/grd



USGS Oil and Gas Energy Assessment

The U.S. Geological Survey (USGS) National Oil and Gas Resource Assessment Team has evaluated the energy potential of U.S. onshore oil and gas resources since 1975, completing its most recent assessment in 1995. The 1995 oil and gas assessment is currently being updated by USGS on a province-by-province basis. The purpose of the USGS energy assessment is to estimate the potential for additions to oil and gas reserves of the United States regardless of land status, classification, or use. The commodities considered in the study include crude oil, natural gas, and natural gas liquids. Undiscovered conventional accumulations of oil and gas, future additions to reserves of known fields, and oil and gas in continuous-type accumulations (called

unconventional plays) are included in the 1995 assessment.

The oil and gas production map was prepared for the Energy Summit using commercially available well data from the Well History Control System database. This database contains nearly 2.5 million exploratory and development wells. The data depicted on the map were generated using a $\frac{1}{4}$ by $\frac{1}{4}$ mile grid - a green (oil) or red (gas) symbol is shown for every grid cell containing a productive oil or gas well. Oil and gas pipelines obtained from the U.S. Department of Transportation are shown on the Midwest, Intermountain, and Pacific West Region oil and gas production maps.

Oil and Gas Development Trends

Future oil and gas development in the western United States includes drilling and production within and around existing oil and gas fields, deeper drilling for undiscovered gas resources, including tight gas sands (low permeability sandstone reservoirs), and the development of relatively shallow coalbed methane resources. In the western United States, 25 national park units lie within two miles of current oil and gas production and future development of oil and gas resources in these areas is likely to occur. As oil and gas fields are delineated

through additional drilling, the areal size of a field may expand as new reservoirs are discovered, or as the true limits of existing reservoirs are determined.

Geophysical Exploration

Before drilling for oil or gas, oil companies commonly acquire geophysical data to help them decide where and how deep to drill a well. Seismic surveys can be designed to image a cross section of the subsurface geology (2D or 2 dimensional survey) or to depict the subsurface in "map view" (3D or 3 dimensional survey). Currently, the most widespread type of geophysical data being acquired to develop oil and gas drilling prospects is 3D seismic data.

The time required to acquire 3D seismic data is considerably longer than for 2D seismic. Whereas work on a 2D survey may be along several lines covering 5 to 20 linear miles, 3D surveys may consist of a gridwork of 20 to 40 source and receiver lines covering 10 to 50 square miles. The 2D survey may last for several weeks with 10 people in the field, while the 3D survey may last for several months with up to 80 people in the field.

Seismic techniques on land use sound energy generated by a near-surface explosion of dynamite or primacord (placed in shotholes or

on the Earth's surface) or vibration (Vibroseis trucks) that travels downward through the subsurface, is reflected off the subsurface rock layers, and returns to the Earth's surface. Instruments that are responsive to the sound waves (called geophones) record the seismic reflections. The seismic data are transmitted to data recorders and processed into a cross-section or map of the subsurface geology. These data are then used to identify areas that may contain accumulations of oil and gas, and in turn, aid the geologist and engineer in pinpointing possible drilling locations.

Geophysical reclamation activities commonly include removing flagging, equipment, and debris and filling in shotholes, but may also involve grading or raking the area to remove ruts and other evidence of trails caused by vehicles, reseeding the area with native grasses and other vegetation, and monitoring the revegetation efforts.

Drilling and Production

New drilling operations require the construction of a gravel access road and wellpad. A wellsite for a single oil or gas well typically covers two to three acres and must be level and capable of supporting hundreds of thousands of pounds of equipment, including large diesel engines, pumps, metal pipe, tanks, and a drilling rig that may be up to 13 stories high. Construction of the wellsite may include clearing vegetation and cutting, filling, and leveling the site. Pits may be constructed to hold large volumes of drilling mud, drill cuttings, and other waste materials from the well. In environmentally sensitive areas, large steel tanks, called containerized mud systems, may be used instead of reserve pits to hold drilling mud and cuttings until the waste products can be disposed of offsite. A water well may be drilled on or near the drilling location to supply water for drilling mud, cleaning the wellsite, etc. If alternate sources of water are available nearby, water may be piped or trucked to the site.

Drilling operations are continuous, 24 hours a day, seven days a week and may last for several weeks to months. Traffic to and from the drilling rig occurs day and night. Well operations include drilling the hole (total depth of the well could range from hundreds to 15,000 feet or more) with a rotary drilling rig, setting several strings of casing (metal

pipe) and cementing the casing in the hole. Once the well is drilled to its total depth, wireline logs are run to evaluate the subsurface formations, and one or more formations may be tested to see if oil and/or gas are present in sufficient quantities to complete the well.

If the well is productive, production equipment will be brought onsite to complete the well and the surface location may be reduced in size for the production operation. Production facilities may consist of large tanks to hold oil and saltwater that is often produced along with the oil and gas, vessels to treat and separate the oil, gas, and water, and pumps and compressors. Transportation of the product may be by tanker truck or may include the construction and operation of oil and gas pipelines. From time to time, service or workover rigs (scaled down versions of drilling rigs), may be used to repair downhole equipment or improve oil and gas production.

If the well produces oil and/or gas in commercial quantities, additional wells may be drilled to further develop the oil and/or gas resources. Typical well spacing mandated by the state oil and gas regulatory agency may be one well every 640, 320, 160, 80, or 40 acres. Completely filled well spacing would translate to 1, 2, 4, 8, or 16 wells per square mile, respectively. In general, oil well spacing is

**Drilling and Production
(continued)**

denser than for gas wells, and shallow well spacing is denser than for deeper wells, including well spacing for coalbed methane wells.

Depending on a variety of factors (the quantity of oil and/or gas in the well, market price of oil and/or gas, project economics etc.), the well may immediately be plugged and abandoned or may produce for a short period of time (weeks or months) to decades (50 years or more).

**Well Plugging and
Surface Reclamation**

Plugging requirements are determined by the agency responsible for regulatory oversight of the oil and gas operation. Oil and produced water are pumped out of the hole and well casing may be cut and removed from the wellbore. Operators set cement plugs in the hole to provide permanent isolation of subsurface intervals (most notably useable aquifers) from all zones bearing oil, gas, geothermal resources, and other economic mineral deposits. A cement plug is set near the surface to plug the well opening, the well is capped, and a surface marker is placed on the location. If contamination of the wellsite is suspected, soil and water testing may be required and the site would be remediated based on requirements mandated by the regulatory agency. The state oil and gas regulator and the surface landowner (usually the U.S. Forest Service, U.S. Bureau of Land Management, or a private landowner) determine surface reclamation requirements. Surface reclamation typically includes removal of all above-ground structures, equipment, and debris, and filling of excavations. Depending on regulatory or landowner requirements, surface reclamation can range from just removing obvious hazards to returning the site to its pre-disturbance condition.

POTENTIAL ADVERSE IMPACTS ON PARK RESOURCES AND VALUES	SUGGESTED MITIGATION MEASURES
All natural and cultural resources	<ul style="list-style-type: none"> - Increase the distance between seismic and well operations and the park boundary.
Contamination of soils and surface and ground waters (aquifers)	<ul style="list-style-type: none"> - Prepare a spill prevention control & response plan for drilling and production operations at the wellsite including identification of toxic or hazardous substances; spill prevention and containment actions; emergency contacts, including park staff; and type of response and clean-up materials and equipment available on site. - Site well downgradient from the park (if possible) or at least 500 feet from the banks of watercourses. - Construct dikes, berms, ring levee/ditch around drilling location. - Use secondary containment around fuel, crude, and brine tanks and other vessels. - Use containerized mud system or lined reserve pits. - Substitute less toxic materials where practicable. - Reduce and properly store wastes. - Run surface casing (or intermediate casing if appropriate) below aquifers and run cement to the surface. - Control rig wash & stormwater. - Plug well in accordance with state standards to protect aquifers.
Alteration of water quantity/quality	<ul style="list-style-type: none"> - Use good stormwater discharge practices to prevent release of contaminants into the park. - Design access road and wellpad to prevent soil erosion in the park. - Design access road and wellpad so that it does not impede surface water flow into the park. - Avoid siting the well in a floodplain or wetland. If floodplains or wetlands cannot be avoided, apply protective measures to prevent release of contaminants into park floodplains or wetlands.
Nuisance or safety hazard from gases such as hydrogen sulfide	<ul style="list-style-type: none"> - Develop warning system and contingency plan for H₂S for drilling and production operations. - Use materials and equipment resistant to H₂S stress cracking where necessary. - Install and maintain appropriate well control and safety equipment.
Fire hazard	<ul style="list-style-type: none"> - Practice good housekeeping of wellsite. - Use proper well control equipment and practices for both drilling and production. - Do not have open fires. - Limit flaring of gases during well testing and production.
Soil erosion	<ul style="list-style-type: none"> - Conduct seismic operations during dry seasons. - Design access road and wellpad to prevent soil erosion in the park. - Do not construct access road and wellpad on steep slopes.
Loss or change in vegetative communities	<ul style="list-style-type: none"> - Avoid clearing of vegetation immediately adjacent to park boundary. - Consult with NPS staff on site restoration methods to prevent exotic plant species introduction in the park.
Harm to wildlife	<ul style="list-style-type: none"> - Advise oil and gas personnel of NPS regulations regarding illegal taking of wildlife on parklands. - Conduct seismic operations during times least likely to adversely affect wildlife. - Restrict public access to the wellsite to reduce potential for wildlife "poaching" in and near the park. - Fence wellsite and net open pits if they attract wildlife.
Harm to threatened or endangered species	<ul style="list-style-type: none"> - Comply with Section 9 of the Endangered Species Act. - Avoid siting seismic and oil and gas operations near threatened or endangered species habitat, particularly during nesting/breeding/migration periods.
Loss or damage to cultural resources	<ul style="list-style-type: none"> - Avoid seismic and well operations in close proximity to park cultural resources. - Use construction and operation methods to confine all drilling and production impacts to the wellpad. - Reduce visual and noise intrusion by selecting an alternative well location, screening wellsite if traditional Native American cultural sites in the park are located near the operation area.
Degradation of air quality	<ul style="list-style-type: none"> - Maintain engines in good running condition. - Control dust during seismic operations and construction of access road and wellpad. - Water dirt access roads during dry periods. - Flare gas instead of venting gas.
Impacts on visitor uses, experiences, and public health and safety	<ul style="list-style-type: none"> - Maintain vegetation near park boundary to screen operations from park visitor use areas such as trails, campgrounds, waterways, picnic sites, swimming beaches, overlooks etc. - Conduct seismic operations during low visitor use periods. - Use engine mufflers, vegetation, or other sound barriers on the wellsite to minimize noise affecting park resources and values. - Erect fences, post warning signs, and limit public access, as appropriate on access roads and on wellsite. - Use downward cast lighting on the wellsite to preserve night sky in the park.